

# alternative energy

## Physics Students Develop Biogas, Hydroponic Systems

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Staff Writer

BIRDSBORO, Pa. — A group of high school physics students are on a mission to show how food production and renewable energy are intertwined.

Members of Daniel Boone High School's Green Team designed, built and are now refining their own methane digester and hydroponics system, which they entered in the Lexus Eco Challenge last month.

The nationwide competition encourages students to investigate environmental issues and educate the community about them.

Last year's Green Team won \$25,000 in the Eco Challenge for an algae biofuel project and put that money into an outdoor classroom and greenhouse in a long-empty school courtyard.

This year's team features only one holdover from last year, as teacher advisers Shannon Helzer and Sid Harwood draw the students from their advanced science classes.

The students typically do not have an ag background, but this year's projects are closely tied to innovations in farm efficiency, Helzer said.

The biogas students even visited a beef farm, where they scooped up manure for their digester.

Cafeteria scraps and water join the animal waste in a 55-gallon drum. Bacteria build up in the barrel and produce hydrogen sulfide, carbon dioxide and methane, team member Elena Chodkowski said.

The gases release into a "scrubber" filled with tap water. Carbon dioxide dissolves in the water, leaving only the combustible gases to

rise to the next stage, Elena said.

In the prototype, the methane and hydrogen sulfide go to a Bunsen burner to be burned off, but they could eventually be used to power the hydroponic team's greenhouse, Rachel Lau said.

The carbon dioxide could be used to support photosynthesis in the previous team's algae bioreactors, Rachel said, and the other leftovers could be used as nutrients for the hydroponic project.

To complete the cycle, the hydroponic plants will eventually be served in the school cafeteria — after being tested for food safety, of course, Helzer said.

The biogas team members have taken shifts at the lunchroom trash cans asking their peers to contribute their leftovers to the cause.

Students are happy to do so, Elena said. "A lot of them ask about it."

Depending on the temperature of the classroom, producing the gases can take a week to a month. A kilogram of biomass generates 40 liters of gases, Quintin Reed said.

The team had to get special permission to keep the lab at 80 degrees F, Harwood said.

The basics of the reactor took a week to build, and the team has been tweaking the design ever since.

The team found plans for several biogas reactors online and took the features they liked from each one, Justin Frey said.

At first, the gases diffused into the classroom instead of being collected in a second container. The weak link was a connecting tube made for liquids, so it was replaced with one designed for gases, Quintin said.



Green Team photo

Green Team members scoop manure for their digester at a beef farm. From left, Abbey Unger, John Dugan and Quintin Reed.

The team also added a check valve and had to select epoxies based on the different plastics being joined. "We learn as we go," Harwood said.

Since the initial input of manure, the team has only added food scraps. They plan to experiment with different foods to see how the outputs differ.

"I expect fruits to have a lot more energy than lettuce," Harwood said.

The project has opened students' eyes to a growing form of energy production. "We didn't know what a biogas digester was," Abbey Unger said.

The hydroponics team, like the biogas team, built their entire system themselves.

They cut holes in PVC pipes and drilled holes in cups for the water to get in. They planted a variety of flowers and vegetables in hydroclay in the cups. A sump pump moves the water through the system, Morgan DeCray said.

The plants are rotated periodically, as the ones nearest the water inlet get most of the nutrients, Helzer said.

The students are spending a lot of time trying to get the nutrients and pH right. The school's water is very alkaline, and Miracle-Gro only made things worse, DeCray said.

Even hydroponic nutrient mixes have not helped so far.

"We killed off almost every one of the plants" at one point, Helzer said.

Rainwater has a pH closer to neutral, and the students have collected

500 gallons of it from the roof of the greenhouse. The team now checks the pH a couple times a week, he said.

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Photo by Philip Gruber

Amelia Fox moves plants in the Green Team's hydroponic greenhouse.



Green Team photo

Abbey Unger, left, and Rachel Lau scoop manure for their biogas reactor at a beef farm.





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